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SUPERPOSED STROBOSCOPIC VELOCITIES

L. E. DODD

The curves plotted from the stroboscopic velocity equation,[1] $v_s = (A - n/m.B)D_0$, (1) and from the derived form,[2] $f = mN - nB$, (2) show that from a given frequency of the stroboscopic figures there is an unlimited number of illumination frequencies that will give the stationary stroboscopic condition, and conversely, for a given value of the illumination frequency there is an unlimited number of frequencies of the stroboscopic figures that will make v_s equal to zero.

To restate the matter in more definite form and to fix ideas in the remarks that follow, reference will be made specifically to the tonoscope drum.[3] By eq. (2) above, for a given row of dots on the drum (definite value of N) there is an unlimited number of illumination frequencies that can produce the stationary condition ($f = O$), and conversely, for a given illumination frequency there is an unlimited number of rows on the drum (supposed of infinite extent) capable of reacting to that illumination frequency with a stationary stroboscopic response.

In the first case, where a fixed value of A (or N) is taken, it may be imagined that several of the unlimited number of illumination frequencies possible are operating at the same time. Mathematically at least, each of these frequencies will produce its own stationary effect, with the simple images caused by it alone having as their distance of separation the quantity D_0/m. If $m=1$ for all of these several frequencies simultaneously present then the resultant effect will have one of two general characters. The first general character will show the appearance produced by one of the illumination frequencies alone, with the exception of a greater intensity of the simple images, and will be due to the several illumination frequencies all catching the stroboscopic figures in the same phase. (A definite "phase" in the sense here used is indicated by a fixed point near the surface of the drum, such as a point on the tonoscope scale.) The second general character will show the appearance of several rows of stationary simple stroboscopic images superposed so that

[1] Proc. Iowa Acad. Sci., XXIV, p. 222, 1917.
[2] Proc. Iowa Acad. Sci., XXV., p. 49, 1918.
[3] Proc. Iowa Acad. Sci., XXIV, pp. 223-224, 1917.

the individual members of a given row do not coincide with those of other rows. This mutual displacement of the stationary stroboscopic rows will be present where the several illumination frequencies do not catch the stroboscopic figures in the same phase, and the nature of the relative displacements depends on these relative phases. (If some of the illumination frequencies are in phase while others are not, the character of the effect is a combination of the two just described.)

In the second case, where a fixed value of B is taken, it may be imagined that several of the possible unlimited number of rows of dots on the drum are superposed to form a single resultant row. Mathematically at least, as many stationary stroboscopic effects will be produced as there are rows of dots superposed to form the one composite row of stroboscopic figures. The resultant stroboscopic effect thus produced by a single illumination frequency will be of the same general nature and have the same two general characters as in the first case. Here, however, it will be a question of the single illumination frequency catching the different rows of dots all in either the same or different phases. (If some of the dot frequencies are in phase while the others are not, the character of the effect is a combination of these two general characters, as in the first case.)[4]

In either of the two cases, v_s for each of the component stroboscopic effects may have a plus or a minus as well as a zero value. Thus, taking say any two of the component effects,[5] they may have the same positive, or negative, or different positive, or negative. velocities. Or one of the pair may have a positive and the other a negative velocity. Thus, where more than two component effects are present the resultant is the complex appearance of a number of rows moving through each other at different rates and in the same or both directions.

But a complex stroboscopic appearance is mathematically possible by a single illumination frequency acting upon a single row of dots on the drum. Thus, with reference to the f and B curves (loc. cit.), for a fixed value of B there are an unlimited number of f values possible, as is seen from the intersections of the line B=constant, with the velocity curves. These f values will in general be both positive and negative, and depending not only on the particular value of B but also on the value of N for which the set of curves

[4]A third possible case may be imagined, a composite of the two just described, where there are several illumination frequencies acting upon several different rows of dots that are superposed to form a single complex row.

[5]By "component effect" is here meant an individual row of simple stroboscopic images due to a given row of dots (given value of N) and a given frequency of illumination.

is drawn, may include the zero value, or stationary condition. Also, with reference to the f and N curves, with B constant, the same possibility is again obvious, from the intersections of the line N=constant, with the velocity curves. The actual production, through a proper choice of the necessary quantities in a suitable apparatus, of such a visual complex effect, confined to a single row of dots on the stroboscopic screen, and due to but one illumination frequency, is an undertaking that would appear to be worth while.

In conclusion, the several mathematical situations described suggest a definite line of experimental study, of possible interest in psychology.

WASHINGTON, D. C.
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